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THE EFFECT OF ELECTRIC ACTIVATION OF WATER-GLASS BINDER ON MOLDING MIXTURE QUALITY

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The results of electric treatment of water glass in a special electrolyzer are described. After this treatment the fluidity of liquid silicate grows more than 2 times while its concentration does not change. This makes it possible to increase the quality of abrasive products containing electroactivated glass by better mixing and exclude the adhesive additive (dextrin) from the mixture formula.

Water glass is a common adhesive component used in the abrasive and casting industry and in other sectors.

Its main property, i.e., its adhesive capacity, makes it possible to firmly bind ceramic components in a molding mixture (electrocorundum powder, powder components of ceramic binders for abrasive production, organic additives, such as dextrin). The fluidity of soluble silicate plays an important role, as it provides uniform moistening and then gluing of molding mixture components over the whole volume.

However, although the use of water glass possessing high fluidity and, accordingly, a decreased density provides for rather uniform moistening of mixture components, the strength of molded preforms in this case perceptibly decreases.

The use of high-density and, accordingly, lower-fluidity water glass, does not ensure a homogeneous distribution of the liquid silicate over the mixture volume and does not achieve the required strength of molded preforms.

It was necessary by means of some technique to increase the fluidity of water glass without decreasing its density, i.e., not diluting it in water.

Such a technique, in addition to the known and still poorly efficient methods (magnetic, ultrasonic, or hydrodynamic treatment), could be electric treatment of the water-glass binder in a special electrolyzer proposed by the authors of the present paper.

The electric treatment (hereafter called "activation") of water glass with modulus 2.9 was performed in a batch chamber activator of capacity 500 cm^3 divided into two chambers by a water-impermeable membrane for 3 – 5 min under voltage of 50 – 60 V and direct current density of 0.02 – 0.05 A/cm^2. We used ceramic membranes, which are the most suitable for the migration of H^-, OH^+, Na^+, and SiO ions from dissociated water and sodium silicate. The properties of activated (A) and ordinary (O) water glass are listed in Table 1.

It can be seen that activation of water glass nearly does not change its density and pH, whereas its fluidity grows more than twice and the redox potential increases by an order of magnitude. The latter factors are presumably responsible for the enhanced gluing capacity of activated water glass.

We also investigated the technological properties of molding mixtures 1O, 2O, and 1A (taking abrasive mixtures as examples) based on water glass with and without dextrin additives. The composition of the molding mixtures is (weight parts per 100 weight parts of grinding grain): 100.0 grinding grain 14A with filler 25; 9.0 ceramic binder K5; 5.4 water glass; furthermore, mixture 1O contained 2.0 dextrin and 0.5 water. The prescribed apparent density of molded samples in all cases was 2.1 g/cm^3.

TABLE 1

Water glass*	Volume density, g/cm^3	Redox potential, mV	Fluidity, g/cm	Prescribed adhesive capacity, g/cm^2	
				0.5	0.2
A	1.495	– 800	3.5	5.0**	2.4**
O	1.496	– 90	1.8	4.2**	1.3**

* In both cases pH = 11.2.

** Actual adhesive capacity.

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TABLE 2

Mixture	Mixer of capacity 5 liters						Mixer of capacity 2 liters		
	Moisture, %	Strength,* g/cm^2			Open porosity, %	Apparent density, g/cm^3	Moisture, %	Strength,* g/cm^2, of molded sample, in	
		molded sample	dry sample	fired sample				0.5 h	6 h
1O	2.6	0.29	10.2	105	39.5	2.23	2.8	0.27	0.26
2O	2.5	0.17	13.0	110	39.0	2.26	2.8	0.16	0.15
1A	2.5	0.29	14.7	113	38.7	2.26	2.3	0.28	0.27

* For prescribed strength 10 MPa.

Water glass and dextrin in a mixture act as a temporary binder and an adhesive additive intended to impart certain strength to molded preforms.

Activated water glass exhibited a better capacity for uniform distribution over the mixture, which ensures more homogeneous mixing of its components.

The properties of molding mixtures are listed in Table 2. It can be seen that the strength of molded and fired samples of mixtures 1O and 1A is at the same level, the strength of dried samples on activated water glass (1A) has grown 40% compared to the strength of samples based on ordinary water glass (1O). This has great importance in firing molded preforms, when their insufficient strength may lead to substantial amount of defective pieces with spalling and edge crumbling. The use of water glass without dextrin (2O) does not provide the required strength in molded samples; therefore, additives are necessary.

The use of activated water glass in abrasive molding mixtures will make it possible to eliminate dextrin or other adhesive additives constituting valuable food materials from the mixture formula and to decrease water glass consumption while preserving the strength properties of molded preforms, improve the uniformly of mixing, and increase the strength of dried preforms and fired products.

Prototypes of electric activators for water glass have been developed and produced at the laboratory of the Volzhskii Institute of Construction and Technologies and industrially tested at the Moscow and Volzhskii Abrasive Works.

The Moscow Abrasive Works has produced several lots of abrasive tools on a ceramic binder using activated water glass. The electric treatment of liquid silicate was performed in a continuous industrial activator designed by the Volzhskii Branch of the VNIIASh Institute. The fluidity of water glass of density 1.51 g/cm^3 after treatment in the electrolyzer grew 2.5 times (from 3.60 to 9.17 g/sec).

Mixtures on activated water glass were technologically adequate in molding and had all required organoleptic properties. Experimental and reference mixtures were used to mold grinding wheel preforms PP of size 125 × 13 × 32 mm and then dried and fired according to the regime accepted at the company. After the end of treatment, the wheels were tested for hardness and mechanical strength on a strength testing stand. The experimental wheels, same as the reference ones, had prescribed hardness (M3, M3 – CM1) and withstood the mechanical strength test at a rotational speed of 40 m/sec. The hardness of the experimental wheels was significantly higher than in the reference ones, which was achieved due to a more uniform distribution of the components in the mixture determined by thinner and more mobile films of activated water glass.

Thus, electric activation of a water-glass binder increases its fluidity, contributes to its more uniform distribution in the mixture, and improves its adhesive capacity. This makes it possible to eliminate the adhesive additive (dextrin) from the mixture formula and to achieve the prescribed hardness of products.